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TRANSACTIONS
of
THE NEW YORK ACADEMY OF SCIENCES

Ser. II, Vol. 5 JANUARY, 1943 No. 3

SECTION OF BIOLOGY[1]

DECEMBER 14, 1942

PROFESSOR THOMAS HUME BISSONNETTE, Head of the Department of Biology, Trinity College, Hartford, Connecticut: *Some Recent Studies on Photoperiodicity in Animals.* (This lecture was illustrated by lantern slides.)

HISTORICAL

Bissonnette[1] showed that the pelt-cycle of ferrets or fitch were photoperiodic reactions related to cycles of the anterior pituitary and controllable by appropriate daily lighting. Bissonnette and Wilson[4] found that pelting-time in the mink could also be controlled by similar light-control and winter prime pelts secured in August and September, instead of November, by appropriate reduced daily illumination. But neither of these animals is good for a careful analysis of the times and courses of the molts and growth of new hairs by which changes of color of pelt or pelage are brought about in mammals, or of plumage in birds, because the new coat is very similar to the old one in color in both spring and autumn.

Weasels were then chosen for the experimental study of the factor or factors in the environment the changes of which induce the spring and autumn molts and replacement of fur. The short-tailed or Bonaparte weasel (*Mustela cicognanii cicognanii* Bonaparte), in Connecticut,

[1]The Section of Geology and Mineralogy was addressed on December 7, 1942, by Doctor Paul D. Krynine on *The Evolution of the Sedimentary Rocks during a Diastrophic Cycle.* (Illustrated by lantern slides.) No abstract was submitted for publication. No meetings were held in December by the Sections of Psychology and Anthropology.

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Executive Secretary: Eunice Thomas Miner.
Assistant Editor: Ethel J. Timonier.
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changes to white or near white in winter, while the long-tailed or New York weasel (*M. frenata noveboracensis* (Emmons)) changes to a lighter shade of brown (Goodwin[7]; Hamilton[8]). Three Bonaparte and eight New York weasels were secured from a trapper in Pennsylvania from a single neighborhood. One was an abnormal male Bonaparte weasel that apparently controlled its own light-cycles while on normal daylight cycles with controls for two years and also when on experimentally controlled lighting. The vagaries of its molts and changes of color have been described by Bissonnette.[2] The other Bonaparte weasels and the New York weasels underwent the usual pelt-changes at the usual times when on normal light-cycles and were therefore considered to be normal in these respects and strictly comparable for experimental purposes.

The conflicting conclusions of recent workers on this general problem may be pointed out. Miyazaki[12] found that shortening days induce molting in the Japanese Mejiro bird, or white-eye, and that increased lighting in the molting period led to irregular and abnormal regrowth of feathers. Witschi[16] concluded that altered environmental conditions, in Iowa, including lighting, do not affect plumage-cycles in the weaver finch (*Pyromelana franciscana*) which depend upon cyclic hypophyseal activity. Brown and Rollo,[5] in Illinois, experimentally modified the plumage-cycles of whydahs and weaver finches (*Steganura paradisea*, *Pyromelana franciscana*, and *Vidua principalis*). The first two species do not normally come into nuptial plumage until two years of age. But, on sixteen hours of light per day, all three species came into nuptial plumage in the first year, with *Pyromelana* most, and *Steganura* least resistent to light treatment. On sixteen-hour light-periods, a *Pyromelana* remained in nuptial plumage for over a year, while a control, on normal daylight, went into eclipse just over a month after the experiment began in December. A yearling male on restricted daylight periods, in process of molting from eclipse to eclipse, very soon began to regenerate nuptial feathers when subjected to sixteen-hour light-periods. Type of feather regenerated in a male *Pyromelana* in nuptial plumage, after plucking, was affected by duration and intensity of daily light-periods.

Walton[15] caused mallard drakes to take on eclipse plumage in February–March instead of the normal time in June–July by artificial lighting in addition to normal light-periods. Complete castration did not prevent this in the first year but did in the second. He concludes that eclipse is not caused by testicular hormone directly acting on the feather follicle, but that removal of the testes sooner or later affects some other

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endocrine organ or organs which consequently become insensitive to seasonal change (light) or fail to induce eclipse.

Witschi and Miller[17] found that sex-hormone injections do not affect plumage in European starlings (*Sturnus vulgaris*), indicating that their plumage-cycles are independent of the gonads. Burger[6] found that molting and subsequent refeathering in starlings will occur irrespective of day-length; but a reduction of day-length favors or speeds up these processes. Their inherent rhythm is modifiable by altered lighting.

Lesher and Kendeigh[10] found that *Zonotrichia albicollis* and *Colinus virginianus*, birds with a normal prenuptial molt in spring, will molt out of season if the daily photoperiod is raised to fifteen hours; but *Passer domesticus* and *Junco hiemalis*, normally without prenuptial molt, fail to do so. *Zonotrichia*, *Passer* and *Colinus*, that normally have complete postnuptial molt in late summer, molt similarly in early spring after photoperiod is reduced from fifteen to nine hours, either immediately or by fifteen or by five minutes a day. The time that molt begins and rate of loss of feathers is accelerated at the faster rates of light-reduction. Time taken in renewal was not affected. Appropriate change of photoperiod appears to induce molts of spring or autumn type only in birds normally having that type of molt, not otherwise. To molt or not to molt, on a given change of day-length, is a specific inherited character.

Salomonsen[14] described the plumage and color-changes of the rock ptarmigan (*Lagopus mutis* (Montin)) from birds in nature and pelt-changes in stoats, weasels, and varying hares, among others, from museum specimens and skins in correlation with average temperatures at regions and dates of capture. From these data, without experimental studies, he concluded that change to low temperatures conditions and controls the change to white in these birds and mammals, with varying susceptibility to this change of temperature determining time and degree of whitening with the species. Reduced illumination was dismissed as of minor or no importance. The course of the change in the mammals was not followed, or described in detail. Per Höst,[9] by experimentally controlled lighting, induced changes of plumage color and molting in the willow ptarmigan (*Lagopus lagopus*) irrespective of high or low temperatures. He caused birds to whiten out of season and to return to normal spring plumage and to lay eggs in winter, by appropriately controlled lighting, in Norway. The birds went through their series of molts or altered them, even skipping some, depending on the type of lighting regime.

Lyman,[11] using the varying hare (*Lepus americanus*), found that reduced daily lighting induces molting of brown coat and growth of white hair in autumn; increased daily light-period induces molting of white coat and growth of brown hairs in spring. Either of these changes of color can be induced out of season by proper lighting. He found a pre-winter physiological condition giving a minor molt from brown to brown before the major molt from brown to white. He plucked areas on the shoulders and noted the color of regrowth, and so did not follow the wave of change over the animals nor the effects of quickly reversed changes of lighting. He found that either castrated or thyroidectomized hares responded like entire animals to the light-manipulation. So it appears that neither the sex-glands nor the thyroids are essential to the molts or color-changes in hares.

Miss Rothschild,[13] using the stoat or English ermine (*Mustela erminea*), found that she could not induce or initiate molts by changes of temperature; she could hasten the completion of the winter molt and growth of white hair in some animals by lowered temperature, causing change to white to be completed in seventy hours. Not all stoats, even from the same litter, became white in winter under similar conditions of temperature, which seemed to control the whiteness of the coat. She described the course and order of whitening of parts of the animal and pointed out that both seasonal changes are by complete molts and growth of new hairs.

Our experiments, described below, on the Bonaparte and New York weasels, give results in agreement with those of Lyman, Höst, Lesher and Kendeigh, Burger, Bissonnette, and Bissonnette and Wilson, on nearly related species. It may be said here that the New York weasel agrees with the Bonaparte weasel in cause and times of molts, but fails to become white both normally and experimentally in this locality under the conditions of our experiments. Effect of cold upon speed of autumn molt was not tried.

Local races of weasels have apparently been selected out which behave differently as regards change to white in winter although of the same species. In Connecticut, the New York weasel changes merely to lighter brown in winter; but farther north in the boreal zone and northern New York State, about fifty per cent turn white with a sex difference in that it is the males that fail to turn white and females do so.[8] We find that the males are more venturesome than females and spend more time outside their dens or looking out. This leads us to suspect that less

reduction of light in autumn, in spite of greater cold in the open, enables the males to be less affected than the females that more often stay in the dens, rather than less reduction in temperature or loss of sight of snow. The latter is believed by some to be the cause of whitening in those animals that become white in winter. If cold or sight of snow were the determining factor the males should be the ones to whiten. Cold may cause the females to stay in the dens and so reduce their daily light-period more than that of the males. In that way it might indirectly help to induce whitening by reducing daily light-time.

Dr. Raymond Hall, of the University of California at Berkeley, pointed out in a letter that *Mustela frenata* at Berkeley remain brown in winter, while the same species at Salt Lake City, Utah, become white, as do those at Lake Tahoe, in the Sierra Nevada. Transfers from Berkeley to Lake Tahoe remain brown in winter in the new locality, and transfers from Salt Lake City to Berkeley turn white as they did at their original home site. This all points to the necessity of using animals from one locality and similar in normal behavior for experimental studies of this sort, lest differences in normal behavior carry over into the experimental results.

Material and Methods

On the working hypothesis that change of daily illumination is the factor concerned in these color reactions, the time and rate of change of daily lighting was altered experimentally for one Bonaparte and four New York weasels while the other two Bonaparte and four New York weasels served as controls on normal light-cycles, to see if time and rate of change of pelt in both species would be changed thereby. All were kept in the same room under like conditions of temperature and dark-colored surroundings at Hartford, Connecticut. The animals all came from the same locality in Pennsylvania. On two occasions controls were moved to a warmer room while experimentals were subjected to additional lighting after dark, but in these cases the warmed room would act against the added lighting if temperature were a factor in the results. Temperatures in the experimental room were not rigidly controlled but showed little or no seasonal variation except greater daily fluctuations when the heating system was operating than in summer when it was not. In general it was near a mean between maximum and minimum daily temperature in summer and above both in winter. The arrangements were such as to rule out temperature changes and the sight of snow or

similar bright surroundings as factors in the results or deviations of experimental animals from the controls, because these are the two factors most often given as the causes of change to white in winter for such animals and return to dark colors in spring. Food and care were alike for both groups of animals. The den and runway system in use was that described by Bissonnette and Bailey[3] and a small darkroom built in the large room was used to shorten days below normal and electric lights to prolong them beyond normal when called for in the experiments.

Photographs of experimentals and controls were made for comparisons at suitable times and to follow the wave of change over the body and extremities of the animals.

For the experimental group, the daily period of light was reduced by one-half hour each *five* days from May 23, 1939, to seven hours on July 20, then to six hours on September 20; kept at that period until November 12; then increased by one-half hour each *four* days to twenty hours, February 27 to March 2, 1940; then reduced again at the same rate to one hour per day on July 30–August 2; then increased likewise to twenty hours, December 28, 1940–January 6, 1941; and reduced directly to normal day-length of about nine hours and thirteen minutes. From that day onward these animals were on normal days, as the controls had been up to this time.

On April 12, 1941, the surviving two Bonaparte controls and one female New York control were treated to experimental light-manipulation, while the surviving Bonaparte experimental and a male New York control were left on normal days as controls, until December 1, 1942. In this way each animal served as control against itself in two or three seasons and as experimental against normal controls as well throughout. These new experimentals were subjected to reduction of daily lighting by one-half hour each four days to one hour per day, July 13–16, inclusive, then to additions at the same rate to nineteen hours December 4–7, then by one hour each four days to twenty-four hours, December 24–January 1, 1942; then reduced one hour each four days to fifteen hours, February 3–6; then directly to normal days, February 7–March 10; then to four hours per day, March 11–24; then to one hour March 25–April 10; and back to normal days of approximately thirteen hours from April 11 onward. These changes were to test whether it is change of day-length that is the factor or mere length of day itself that induces the changes in color.

Results and Conclusions

Temperature change was not an appreciable factor in the observed modifications of times of molt, pelt and color cycles, or degree of molting in these animals. It is therefore concluded that temperature-cycles do not control molting or color-changes in these weasels except perhaps indirectly as suggested below. Neither is color, nor change of color, nor whitening of surroundings in control.

Reducing daily periods of light, either gradually or suddenly, induced molting and regrowth of new fur in varying degrees for both species of weasel: in the Bonaparte, white replaced brown, and in the New York weasels, lighter brown replaced dark brown on the body and some white appeared on the feet. The black tail-tips remained black throughout. (In what follows read light brown instead of white for New York weasels.)

Increasing daily light-periods caused molting and change to dark brown in varying degrees over the bodies in both species.

Incomplete molts and change of color in both directions (toward white or toward brown) were produced as a result of early reversal of increase or decrease of daily light-time. This sometimes left the animal for some months at a time with parts of its body showing hairs of each of three consecutive growths of hair.

Even on normal days, molts and change of pelt in either direction are not always complete, and vary in the same animal. Thus "gray-backs" in winter and animals with some white in places on the body usually turning brown in summer occur among controls. "Gray-backs" also occur in nature and probably so do cases of incomplete summer browning. These are quite easily accounted for if daily light-periods control molting and change of color.

Usually the autumn molt and change to white hairs comes as a wave over the body from below upward and along the tail from below and base to top and tip, with the last parts to turn white being a spot between the ears and down the nape of the neck, with occasional spots on the hips. This is much better adhered to than the usual method of change to brown. The latter usually begins around the lips and along the ridge of the back and top of the head and sweeps downward on the body and backward on the tail toward the tip. But if change to longer days comes before the white fur along the back is completely grown in, the brown may appear along the sides and flanks and spread upward and downward and leave the back of the animal and a ring on the tail next the black

tip, and some of the legs and feet and face, white through the period of the otherwise brown coat. The same animal may react in either this manner or the normal one in different seasons. Animals may be induced to molt from white into white or from brown into brown by proper lighting. The colors need not alternate with each other. Animals were made to assume white coats in spring at about the same time as controls were becoming brown; and to become brown before Christmas after whitening early in the autumn. Two cycles of color-change were obtained in about one year instead of the one that is normal, by subjecting the animals to two light-cycles in the year.

A latent or adjustment-period always intervenes between the time of increase or decrease of light-ration and the shedding and regrowth of hair. This appears to be about three months or less. Whether this is amenable to experimental change of duration is not yet clear. The internal reaction-system takes time to adjust to stimulating change, if this is a sudden large reduction of increase in daily light-time or not.

Not all animals of the same species react alike, even if secured from the same locality, and the same animals react differently in different seasons or years. Local races in which a majority react alike are probably produced by natural selection, such that in regions with snowy winters a majority turn white in autumn and continue to do so after removal to regions where there is little or no snow in winter, and a majority remain brown in winter in regions where snow is scarce and continue to grow brown winter coats when removed to regions with winter snow. Studies on this general problem should therefore be made with animals known to react alike in a given season and from the same local race. In such cases, the place or locality where experiments are carried out is of little or no importance.

After light-manipulation and consequent modified color-cycles lasting through two years or longer and several color-changes, the animals return to normal pelt-cycles after return to normal light-cycles in a normal direction or manner; but not if such return is abnormal, i.e., too abrupt or in an unusual direction. Return to normal days from longer days induced whitening in the Bonaparte weasels; from shorter days, browning, in spring or summer.

That this stimulus is received through the eyes and acts through the anterior pituitary is indicated from Bissonnette's studies with ferrets[1] and that the thyroids and sex-glands are not essential to it is at least suggested, if not indicated, by Lyman's[11] study on the varying hare.

These results and conclusions are in agreement with those of Höst,[9] Brown and Rollo,[5] Lesher and Kendeigh,[10] Miyazaki,[12] Walton[15] and Burger[6] from studies on birds, and suggest that this phenomenon is of quite broad distribution among birds and mammals. That this is invariably the controlling factor in such changes is by no means demonstrated. As with sexual periodicity, it is probable that other factors may operate in other animals to bring about the synchronization with the seasons. Temperature reductions, or any other factor or factors which drive the animals into their dens or underground into the dark for longer hours, may indirectly induce the taking on of white or near white coat in autumn, and the reverse may induce change to brown in spring. Changed habits of the animals in this regard may be self-imposed and bring about unusual times and degrees of change of pelt-color or molts.

These studies were aided by grants from the Penrose Fund of the American Philosophical Society, 1938–1939, and from the American Academy of Arts and Sciences, 1942. The paper on the work *in extenso* will be published elsewhere under the authorship of Thomas Hume Bissonnette and Earl Elmore Bailey, Trinity College, Hartford, Connecticut.

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REPORT OF THE ANNUAL MEETING

DECEMBER 15, 1942

The 125th Annual Meeting of the Academy for the election of Officers, Fellows and Honorary Members, the presentation of reports and the transaction of other business was held at The American Museum of Natural History on the evening of Tuesday, December 15.

The Corresponding Secretary reported that there are now 44 Honorary Members and 4 Corresponding Members upon the rolls of the Academy. Four deaths were reported during the past year.

The opening paragraph of the Recording Secretary's report of last year serves as an excellent beginning for this year: "The most outstanding fact regarding the Academy this year is the continuance of its substantial progress, in spite of existing world conditions."

Celebrating the 125th year of its founding, the Academy has maintained and, in some respects, improved upon the records previously established. The continuance of its program of progressive activities, especially that part concerned with the meetings and publications, is a noteworthy accomplishment in, this, our first year of war.

Plans for the extension of our progressive program have been made with a keen realization that science, like all other educational and cultural phases of civilization, must play its part by making the greatest possible contribution in ideals and achievements toward future world stabilization.

The Council is deeply appreciative of the support and cooperation given the Academy by its Members.

During 1942, the Academy held 27 Regular Sectional Meetings, at which 27 stated papers, all of high caliber, were presented, in addition to the Annual Business Meeting and Dinner, at which two excellent addresses were delivered. Six informal receptions were held under the auspices of the various Sections of the Academy.

The Section of Oceanography and Meteorology held a conference on "Boundary Layer Problems in the Atmosphere and Ocean." This symposium was attended by a large number of outstanding workers in these fields and initiated the activities of the new Section.

The Section of Physics and Chemistry held three conferences on special subjects of research, under the following titles: "Protein Hormones of the Pituitary Body," "Physics of the Solid State," and "Color, Constitution and Reactions of Dyes."

The membership of the Academy not only has been sustained successfully in financial support, but, in this respect, has improved its record by an increase of income. Although a small net loss of membership is shown, it seems advisable to point out that this is due to the termination of membership for those not in good financial standing during the past two years.

Two Honorary Members, 2 Life Members, 116 Active Members, 46 Associate Members and 2 Student Members were added to the rolls, of which 156 are now in good standing and 12 await qualification through payment of dues. Thus, a total of 168 new Members were added during the year.

The present membership of the Academy is 1,964 Members, of which there are 259 Fellows, 1 Patron, 105 Life Members, 134 Sustaining Members, 1,017 Annual Active Members, 634 Associate Members, 25 Student Members, 44 Honorary Members and 4 Corresponding Members.

The Editor reported that during the fiscal year of 1942, the Academy has published 778 pages as of this date. Of this amount, 382 pages were published in the Annals, 258 pages in the Transactions, and 138 pages in the Scientific Survey of Porto Rico and the Virgin Islands. It is also appropriate to announce that the 125th Anniversary Volume, being Volume II of Special Publications, is printed and now being bound, and will appear before the end of December, 1942. This comprises xvi, plus 178 pages and 100 plates, bringing the total pages to 1072. In addition, Article 6 of Volume 43 of the Annals is now in galley proof, and Article 1 of Volume 44 of the Annals has been sent to the printer in manuscript form. These two papers will comprise some 280 pages, to appear early in 1943.

An itemized list of these publications follows:

ANNALS

Volume 42, Article 4—"Intelligence in Mental Disorder," by Anne Roe and David Shakow. Pages 361–490. Published January 31, 1942.

This completes Volume 42.

Volume 43, Article 1—"Thermodynamic Properties of Solutions of Long-Chain Compounds," by Maurice L. Huggins. Pages 1–32. Published March 30, 1942.

Volume 43, Article 2—"Immunochemistry," by William C. Boyd, Enrique E. Ecker, Michael Heidelberger, Sanford B. Hooker, Forrest E. Kendall, Stuart Mudd, L. Pillemer, Joseph E. Smadel, Theodore Shedlovsky, and Charles A. Zittle. Pages 33–122. Published April 30, 1942.

Volume 43, Article 3—"Studies on Fresh-Water Bryozoa. XII. A Collection from Various Sources," by Mary D. Rogick and Claudeous J. D. Brown. Pages 123–144. Published May 12, 1942.

Volume 43, Article 4—"An Analysis of the Locomotion of the Seahorse, *Hippocampus*, by Means of High Speed Cinematography," by C. M. Breder, Jr., and H. E. Edgerton. Pages 145–172. Published June 20, 1942.

Volume 43, Article 5—"The Ultracentrifuge," by D. A. MacInnes, W. J. Archibald, J. W. Beams, W. B. Bridgman, Alexandre Rothen and J. W. Williams. Pages 173–252. Published October 6, 1942.

Volume 43, Article 6—"Protein Hormones of the Pituitary Body," by H. B. van Dyke, Bacon F. Chow, Vincent du Vigneaud, H. L. Fevold, George W. Irving, Jr., C. N. H. Long, Theodore Shedlovsky and Abraham White. Pages 253–000. *In galley proof.*

This will complete Volume 43.

THE SCIENTIFIC SURVEY OF PORTO RICO AND THE VIRGIN ISLANDS

Volume 19, Part 1—"Meteorology of the Virgin Islands," by Robert G. Stone. Pages 1–138. Published October 28, 1942.

TRANSACTIONS

Transactions, Series II, Volume 4, constituting a 258-page volume in 8 numbers, has been printed and distributed.

SPECIAL PUBLICATIONS

Volume II—"Balinese Character, A Photographic Analysis," by Gregory Bateson and Margaret Mead. Pages xvi, plus 178, and 100 plates of photographs. This volume is in commemoration of the 125th Anniversary of the Founding of The New York Academy of Sciences. Published December 7, 1942.

The Librarian reported that 13,309 separate publications and 2,080 complete volumes of Transactions, Series II, Volume 4, were distributed to the members of the Academy, authors, exchanges and the sales list, classified as follows: *Annals*, 7,975; *Scientific Survey of Porto Rico and the Virgin Islands*, 562; *Special Publications*, Volume I, "Climate and Evolution," 29; and *Transactions*, Series II, Volume 4, complete volumes, 2,080 and 4,743 single copies.

The Library of the Academy has received 913 separate publications from exchange institutions.

The Treasurer reported that considering the difficulties that war brings to all institutions, often causing them severe hardship in the maintenance of their activities, the Academy has made a remarkably good record this year.

The total income received from all sources amounted to $22,750.31.

Receipts from sales of publications, amounting to $2,679.87, shows an increase, during 1942, as compared with the total publications sales of last year.

The Members of the Academy, showing an ever progressing interest in the Academy's welfare, added 168 new names to its rolls, thus producing a gain of $104.25 in revenues from dues above that of last year, making a total of $7,856.54 from this source. This is exclusive of $400.00 received for Life Memberships.

The investments of the Academy have remained the same during the past year, except for the sale of certain stock rights. The investment portfolio was carefully watched and it was deemed wise to make no changes at this time.

The book value of the Academy's property, as of November 30, 1943, amounts to $92,490.49, of which $76,787.67 is in stocks and bonds, $14,770.15 is in real estate and $920.07 is in a mortgage bond.

As usual, the books of the Treasurer were duly checked and balanced at the end of the fiscal year, November 30, 1942, and audited by the Finance Committee, as provided by the Constitution and By-Laws. The property of the Academy was verified and the Treasurer's Report examined and attested by the Finance Committee as of December 14, 1942.

The A. Cressy Morrison Prizes of $200.00 each for the two most acceptable papers in any field of natural science, within the scope of the Academy and its Affiliated Societies, were awarded to the following papers,[1] entitled:

"New Methods in Stellar Dynamics," by S. Chandrasekhar, Yerkes Observatory, Williams Bay, Wisconsin, and "Comparative External Anatomy, Phylogeny, and a Classification of the Bees," by Charles D. Michener, The American Museum of Natural History, New York, N. Y.

Honorable Mention was given to the papers entitled, "The Relation Between Centriole and Centromere in Atypical Spermatogenesis of Viviparid Snails," by Arthur W. Pollister and Priscilla F. Pollister, Department of Zoology, Columbia University, New York, N. Y., and "The Haplolepidae, a New Family of Late Carboniferous Bony Fishes," by Doctor T. Stanley Westoll, Department of Geology and Mineralogy, University of Aberdeen, Scotland.

The Committee takes great pleasure in congratulating the authors of these papers and desires to express its appreciation of this method of

[1] Abstracts of these papers are included in this issue of the Transactions.

bringing to the attention of the Academy valuable and outstanding records of scientific research.

The following members were elected to Fellowship:

Donald H. Andrews, Ph.D.
Gregory Bateson, M.A.
Robert M. Burns, Ph.D.
Bacon F. Chow, Ph.D.
Thomas Francis, Jr., M.D.
Julio Garcia-Diaz, Ph.D.
Otto H. Haas, Ph.D., LL.D.
Arthur J. Hill, Ph.D.
Columbus Iselin, 2nd, A.M.
Joseph L. Johnson, M.D., Ph.D.
Alois F. Kovarik, D.Sc., Ph.D.
Perrin H. Long, M.D.
Joseph E. Mayer, Ph.D.
Eunice Thomas Miner
Raymond B. Montgomery, Sc.D.
Ross F. Nigrelli, Ph.D.
Lars Onsager, Chem. E., Ph.D.
Charles E. Resser, Ph.D., Sc.D.
David McKenzie Rioch, M.D.
Robert Rugh, Ph.D.
Herbert J. Spinden, Ph.D.
Wendell M. Stanley, Ph.D.
Harold C. Urey, Ph.D., Sc.D.
Alexander Wetmore, Sc.D., Ph.D.
John C. Whitehorn, M.D.
Harold G. Wolff, M.D.

Honorary Life Membership was conferred upon the following eminent scientists:[1]

Arthur H. Compton, Ph.D., Sc.D., LL.D., Physics, Charles H. Swift Distinguished Service Professor, University of Chicago, Chicago, Illinois.

Clinton Joseph Davisson, Ph.D., Sc.D., Physics, Member Technical Staff, Bell Telephone Laboratories, New York, N. Y.

Thomas Hunt Morgan, Ph.D., Sc.D., M.D., LL.D., Biology, Genetics, Director, William G. Kerckhoff Laboratories, California Institute of Technology, Pasadena, California.

Harald Ulrik Sverdrup, Ph.D., Oceanography, Meteorology, Professor of Oceanography, University of California, and Director, Scripps Institution, La Jolla, California.

The following officers were elected:

For President
HORACE W. STUNKARD

For Vice-Presidents
WALTER H. BUCHER
LAWRENCE K. FRANK
THEODORE SHEDLOVSKY
RALPH H. CHENEY
GREGORY BATESON
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[1]The class of Honorary Life Membership of The New York Academy of Sciences is limited to fifty.

After the Business Meeting, the following program was presented:

"The Mobilization of American Scientists for War"

by

FRANK BALDWIN JEWETT

"Direct Lift Aircraft"

(Motion Pictures in Color)

by

IGOR L. SIKORSKY

S. CHANDRASEKHAR, Yerkes Observatory, Williams Bay, Wisconsin: *New Methods in Stellar Dynamics.*[1] (A. Cressy Morrison Prize Winner, 1942.)

This paper presents a condensed version of certain new methods to investigate the dynamics of stellar systems. The statistics of the gravitational field are applied to the case of a *moving* body. It is shown how the upshot of the accidental fluctuations in the field produce a secular slowing down of bodies (stars) that have relatively high velocities, in this way retarding the escape, e.g. of stars from clusters. The rate of escape of stars from clusters is one of the leads used in evaluating the age of the universe.

CHARLES D. MICHENER, The American Museum of Natural History, New York, N. Y.: *Comparative External Anatomy, Phylogeny, and a Classification of the Bees.* (A. Cressy Morrison Prize Winner, 1942.)

It is the purpose of this paper (1) to add to the knowledge of general insect morphology and determine the homologies of certain previously unexplained structures, (2) to provide a uniform terminology for structures, (3) to discuss the comparative anatomy of bees and, with this as a basis, (4) to suggest the interrelationships of the various groups of bees and to provide a classification with keys to the families, subfamilies, and tribes.

In order to fulfill these objectives a detailed study was made of the skeletal morphology of *Anthophora*, a bee of intermediate specialization.

[1] Abstracted by Professor Jan Shilt, Columbia University, New York, N. Y.

Wherever desirable, comparisons with other Hymenoptera or with insects of other orders were made in order to establish the homologies and the proper names for parts. Then numerous other bees, selected from all of the major subfamilies, were compraed with *Anthophora*. Finally, with these comparisons as a basis, a phylogenetic system and classification were devised.

The great majority of the modifications of *Anthophora* as contrasted with the lower Hymenoptera subserve but two functions, feeding and flight.

In the course of the work on comparative morphology, much evidence for parallel development of certain structures was obtained, and it is concluded that the most used classification of bees, based on the presence or absence of the pygidial plate, is unnatural, since this structure has been repeatedly lost in the course of evolution. A new phylogenetic tree is presented, based on numerous characters. The Paracolletini are regarded as the most primitive living bees. It is shown that with the exception of forms nesting in wood, most of the bees of Australia belong to primitive families.

The study of comparative anatomy and classification revealed numerous characters either ignored by previous students or not observed by them which are of utmost importance in determining the relationships of bees and even in identifying them. In the section on classification, keys are given to the families, subfamilies, and tribes of the world and to the genera of America north of Mexico. Six families, 22 subfamilies, and 32 tribes are recognized.

ARTHUR W. AND PRISCILLA F. POLLISTER, Department of Zoology, Columbia University, New York, N. Y.: *The Relation between Centriole and Centromere in Atypical Spermatogenesis of Viviparid Snails.* (Awarded Honorable Mention, A. Cressy Morrison Prize Competition, 1942.)

The centrioles and chromosomes have been intensively studied in typical and atypical spermatogenesis of *Viviparus malleatus*; and brief confirmatory observations have been made on three other species of viviparid snails.

Typical spermatogenesis has no unusual features. The two nucleoli fuse when their associated chromosomes synapse. This fusion nucleolus disappears before the stage of diakinesis. The two centrioles of the first

meiotic prophase take positions at the idiozomal pole of the nucleus in leptotene; and they remain there until they move apart to the spindle poles of the first division. The centrioles divide in the telophase of the first division; and one of the four thus formed is included in each of the four spermatids.

Atypical spermatocytes become much larger, due to more cytoplasmic growth. There is no synapsis. At a stage which seems, from the disappearance of the nucleolus, to be early diakinesis, the sister chromatids separate from one another. As a consequence, in late diakinesis the nucleus contains 36 (4N) separate chromatids instead of 9 (N) tetrads. Of these 36 chromatids four show approximately normal anaphasic behavior at the two meiotic divisions. The other 32 behave as if the mitotic orienting mechanism (the centromere, kinetochore, or spindle attachment point) were non-functional or absent. The 32 abnormal chromosomes degenerate, disappearing in the early spermatids.

In atypical spermatocytes the two centrioles grow to be large spheres of equal size, the centriospheres, during the spermatocyte growth period. There is evidence that the growth of the centriosphere is a result of the accretion of material that flows out of the nucleus at its idiozomal pole. At late diakinesis each centriosphere becomes resolved into a number of centrioles, which in size and staining character are like the two of normal spermatocytes of the typical line. Each of these centrioles divides in telophase I, at the normal time for centriole division. At prophase of the second division each centriole is surrounded by a small aster; and each centriole later goes to one pole of the division figure. In most cases in *Viviparus malleatus* one spermatid receives a larger number of centrioles. The atypical spermatozoon is multiflagellate because each centriole functions as a blepharoplast.

From a statistical study of the number of centrioles in the spermatids it is evident that each quartet of related spermatids (those descended from a single primary spermatocyte) contains 36 centrioles—an excess of 32 over the normal 4 centrioles. This number of extra centrioles agrees exactly with the number of chromosomes that behaved as if they lacked centromeres—as if they were, in Darlington's terminology, *acentric*. From this numerical comparison it is concluded that the 32 extra centrioles are actually the transformed centromeres of the 32 acentric chromatids; that of the total 36 centrioles there are 4 true centrioles (corresponding to the 4 of the typical line) and 32 centromeric centrioles. The centriole and chromosome counts in representatives of

three other genera of viviparid snails, which have different chromosome numbers, likewise show that the number of extra centrioles always agrees exactly with the number of chromatids that behave as if acentric.

From the fact that all the centrioles of the atypical line behave like normal centrioles, and show no individual differences in function, it is concluded that centromere and centriole are essentially similar bodies, which normally show differences in behavior only because one is in the nucleus as a part of a chromosome while the other is in the cytoplasm.

Thus it is held that the extra centrioles in atypical spermatogenesis of viviparid snails do not arise, as has always been supposed, by repeated divisions of the two centrioles. Instead, the increased number of centrioles is a result of the contribution from the nucleus—in the form of centromeric substance. In the discussion it is pointed out that in a normal centriole cycle the centriole divides only after it has been in close connection with the centromere by the half-spindle fibre; and it is suggested that the division of the centriole is normally a consequence of its receiving an addition of centromeric substance flowing along the half spindle. The general view that centriolar material always originates from the nucleus is developed; and it is pointed out how this explains some of the hitherto puzzling centriolar phenomena—for example, the appearance of centrioles in the spermatogenous divisions of plants that lacked centrioles in the vegetative divisions.

T. Stanley Westoll, Department of Geology and Mineralogy, University of Aberdeen, Scotland: *The Haplolepidae, a New Family of Late Carboniferous Bony Fishes.* (Awarded Honorable Mention, A. Cressy Morrison Prize Competition, 1942.)

A group of late Carboniferous actinopterygian fishes is described and referred to the genera *Haplolepis* Miller, 1892 (syn. *Mecolepis* Newberry, 1856, *Eurylepis* Newberry, 1857—both preoccupied) and *Pyritocephalus* Fritsch, 1893 (syn. *Teleopterina* Berg., 1936). They are from six localities, of which the stratigraphical horizons can be stated by reference to Dix's succession of coal-measure floras.

In several cases it has been possible to make very detailed reconstructions of the dermal bones and the body, but remains of the endoskeleton are too bad for description.

The fishes are shown to be closely related and sharply marked off from all other known Carboniferous Actinopterygii: the new family,

Haplolepidae, is set up for their reception. It is shown that the family was probably derived from the lower Carboniferous *Canobius*, which in turn is derived, through *Mesopoma*, from a series of "normal" palaeoniscoids allied to *Rhadinichthys*. The family was thus well separated from most Carboniferous evolutionary lines within the palaeoniscoids. It is shown that *Aeduella* Westoll is not a close relative of the Haplolepidae, and that the resemblances are largely due to parallel evolution; and that *Trissolepis* Fritsch, of which the skull-roof has been described as fenestrated in a manner similar to that of *Pyritocephalus*, is probably of normal palaeoniscoid structure with an entire skull-roof. The subgenera of *Haplolepis*, and *Pyritocephalus*, are separate throughout their known range, but *Pyritocephalus* was certainly derived from an early *Parahaplolepis*.

The comparative anatomy of the dermal bones, the body and the fins is discussed in detail. Peculiar modifications of the skull-roof and cheek, some of them independently undergone in different members of the group, are demonstrated. The development and significance of the paired fenestrations in the skull-roof of *Pyritocephalus* are discussed. Attention is given also to the remarkable modifications of the snout, external nares and opercular apparatus; to the presence of a flattened venter between the paired fins, associated with a modified course of the scale-rows of the body; to the frequent development of very deep scales on the anterior flank; to the modifications leading to the extreme thinness of the scales; to the laterosensory system, which is very fully developed and includes main and accessory, together with dorsal and ventral, lateral lines, the last described for the first time in an actinopterygian; and to the significance of the structure and nature of the dermal fin-rays, and of the relative positions of the fins.

Many of the characters demonstrated in Haplolepidae are to be found also in some members of the "Holostei" and "Sub-Holostei." A critical discussion of the status of these unnatural groups leads to a general statement of a new hypothesis of the evolution of the "holostean" condition, in which it is shown that the characteristic modification of the tail-fin has happened independently in different lineages, and is correlated with a great change in habitat and environment. This section is based largely on a consideration of the fish as a swimming organism.

The geographical distribution of the Haplolepidae is remarkably extensive for so specialized a family; in particular, the highly specialized *Pyritocephalus sculptus* from Bohemia is extremely similar in all details

to the contemporaneous *P. lineatus* from Ohio. An analysis of the probable conditions of deposition of the rocks yielding the fossils leads to the conclusion that the Haplolepidae were fresh-water fishes thoroughly adapted to life in stagnant swamps, and almost certainly incapable of migration by sea. The implications of such conclusions in the understanding of the distribution and nature of coal-measure swamps, and on the theory of continental drift, are considered. The faunas associated with Haplolepidae are shown to include certain peculiar Amphibia, the distribution of which is extremely closely correlated with that of the fishes. The fate of this "facies fauna" is described, and the food relations of the various members are briefly noted.